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NOTE ON IRRIGATION
IN THE
DHOLPUR STATE.

1902.

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NOTE ON IRRIGATION IN THE DHOLPUR STATE, 1902.

1. "The greatest length of the State is 76 mile from east to west the average breadth, 16 from north to south. The superficial area is 1,193 square miles."

2. "Starting from the alluvial plain near Dholpur, which is 600 feet above mean sea level, a range of hills runs westward paralled to, and from 3 to 5 miles distant from the River Chambal; from this other ranges spread out until at the western border they occupy the whole breadth of the State."

3. "They are chiefly of a red sandstone formation, and their rocky surfaces are for the most part bare even of trees and shrubs."

4. "A peculiar feature of the State is the vast number of ravines : which though they abound near every nullah are particularly developed near the Chambal." "They are yearly extending and occupy many square miles of the country."

5. "Only one river rises in the State, namely, the Parbati which passes through the Barri, Baseri and Kolasi Perganas, into the Banganga, in the Agra District." "It is fed by numerous small streams rising in the adjacent range of hills, and the characteristics of all are very similar. The beds are mostly rocky, and the banks lined with ravines or a sandy unfertile soil." "Although pools of water are found in the bed of the Parbati; the Parbati river is not perennial, and its affluents are dry in the cold and hot weather, and only full after a heavy fall in the rains."

6. The total area of the State is put down at 7,76,237 acres.

The total area of Khalsa land 5,78,679 acres or 904 square miles; of this quantity hills, ravines and barren ground occupy 2,33,685 acres or 365 square miles. Mafi or Jagir plots 15,097 acres or 23 square miles. Cultivated 2,45,691 acres or 384 square miles. Culturable 84,206 acres or 131 square miles.

7. The density of population per square mile for the total area of the State, according to the last census returns, is stated to be 233, but the large area taken up by ravines and bare hills has to be taken into account.

8. The population of the State is given as :—

Males	...	...	1,57,004
Females	...	...	1,22,720
Total	...	...	<u>2,79,724</u>

The Musalmans numbered only 17,389, and inhabit chiefly Dholpur and Bari Towns.

9. There are 43 Jagir villages with a total area of 31,224 acres.

There are 39 Tankidar villages, 32 belonging to the Rao of Sir Muttra, and 7 to the Rao of Rijhanni, comprising altogether about 1,27,052 acres.

10. The Khalsa villages number 419, covering 5,78,679 acres, or 75·3 per cent. of the entire area of the State.

11. *Rainfall*.—Average for the State is said to be about 25 inches.

12. *Means of Irrigation*.—"Tanks irrigate a very small area." From State Tanks, the area is stated to be about 2,041 acres.

"The first attempts appear to have been made in the times of the Mohammedan Emperors. The best example exists at Khanpur from which some 350 acres are now irrigated."

"Since that period, with the exception of repairs to a few Tals, nothing has been done owing to the financial condition of the State, until 1896-97, when the necessity of employing famine labour, caused the Tals of Nurpura, Oomree, Sheikhpur and some smaller ones to be constructed on hurriedly collected data."

13. The amount spent is stated to be in Khalsa land, Rs. 73,932
 " " " (estimated to be) in Jagir " " 33,000
 " " advanced in Takavi during the
 same period is said to be 29,245

14. *Wells*.—The chief source of irrigation is wells.

It is stated that these are now :—

	Total.
Masonry Wells in Khalsa land 4,501	} 4,877
" " " Jagir " 376	
Kachcha " " Khalsa " 8,166	} 8,169
" " " Jagir " 3	

Kachcha wells are sometimes lined with munj or sarpata grass, a ring of rope about four inches thick.

15. The average area irrigated per run, is stated to be about 4·1 acres; and the cost per acre about one rupee for one watering.

16. The depth at which water is found varies, except at Rajakhara, where the water is from 60 to 80 feet deep, and sometimes more; water is no where very deep. In Barri, Baseri and Kolasi Perganas it is usually found at about 30 feet, rarely more, sometimes less.

17. The total area under cultivation is stated to be now :—

	Acres.
In average years—In Khalsa	2,56,986
" " " Jagir	45,382
Total ...	3,02,368

of this quantity, the area irrigated from wells is			
stated to be in Khalsa	...	...	Acres. 83,343
Estimated area in Jagir and Mafi ..			Acres. 7,906
The total culturable land in Khalsa	3,45,910	} ...	4,11,213
" " " " " Jagir	65,303		
" " unculturable " " Khalsa	2,34,863	} ..	3,52,249
" " " " " Jagir	1,17,386		

18. There are no Jheels or depressions not already used which can be drained and cultivated ; all such places are said to be now cultivated.

19. Thirty-one Tanks, as Irrigation Works have been proposed by the State Engineer, Mr. A. N. Thorpe, who evidently takes an interest in the subject ; but only four of these have been estimated, and these will probably need revision.

20. The larger projects Nibi, Seheri, Thomati- Mohari and Mhar, have been inspected by the Consulting Engineer in company with Mr. Thorpe. Notes regarding each are attached. (See Appendix.)

21. The people certainly appreciate the value of water, judging from the many small Tals which are met with ; but they seem to prefer to let out the water for the cultivation of the bed ; probably this is owing to the ease with which it is done, and because they have not had enough water, to irrigate any quantity of land by flow.

If they could have a canal or supply for any large area, they would no doubt see the value of such irrigation and appreciate it.

22. The whole country slopes from the rocky range of hills on the west and south-west towards the east and north-east.

"Owing to the slope of the catchment and the friable nature of the soil, all the rivers and nullahs have cut their beds deep, much below the surface level, and the smallest nullahs are surrounded by ravines, which would render the cost of any attempts at utilising their waters by flooding prohibitive."

23. The bare rocky range of hills at the highest part of the State is in fact a source of danger as well as an advantage to the State. The danger consists in the large share of rainfall which runs off (50 per cent., more or less is stated by Mr. Thorpe,) and the velocity with which it flows, is so great that only rock can withstand it, and unless this is counteracted in some way, or the water cuts down to rock it is only a question of time, though perhaps a long time, as to the extent of the ravines.

24. On the other hand, as this range of hills is at the highest part, the extreme end and side of the State, any water stored here, would command all the land to the eastward, to the boundaries of the State.

Nature could not have arranged better for the interest of Dholpur. If only good use is made of the opportunities afforded, enough water falls at the highest part, to irrigate the greater part of the State, and make it absolutely safe against famine.

25. "There are no perennial streams flowing through the State with the exception of the River Chambal, which forms the southern boundary of the State; but its bed is about 130 ft. below the level of the surrounding country, and it is bounded by ravines spreading out to the foot of the hills, which rise some 500 ft. above the plain." "Any idea of utilising this river may therefore be discarded."

26. The only means for promoting irrigation are by *storage tanks* and *wells*.

Wells may no doubt be profitably made in many places, and arrangements for making them can be made by the civil authorities, as circumstances admit, without professional help.

Storage Tanks.—It would be difficult to find a State better adapted for making Storage Tanks.

Almost every depression near a village, can be made use of. Many examples exist already, where the villagers have thrown up small banks of earth, generally faced with stone, where a little water is collected in the rains and the bed, which would not exist, but for this small Bund, is cultivated afterwards, and perhaps a patch below the Bund also.

28. The rocky nature of the ground ensures the Tal filling, even with a small fall of rain, and the percolation from the water stored, keeps the village well supplied, when it would otherwise be dry.

29. There are many places too no doubt where the valley, if long enough might be terraced and two or more Tals be made, and the water be sufficient to fill one Tal after another.

The construction is so simple and so well adapted to the wants and capabilities of the people that such works are deservedly popular; such works are specially suitable too for Relief Works, as they would spread relief over a large area, would be near the villages, and so keep people from leaving their homes, and would not require much supervision, beyond the general alignment and levels; and the construction of proper escapes, from want of which some Tals have been breached.

30. I would strongly advise this class of work being properly arranged for; every village should be reported on, if it has such a Tal, if it is in proper repair? if it has not, whether it is possible to make any small work of this sort?

The State Engineer could then prepare plans and estimate for each Pargana, and the works can be carried out gradually, or be ready in case of need.

Mr. Thorpe the State Engineer is, I believe, taking steps to repair all such Tals where possible, but there is much to be done.

31. In some places it may be possible to make long low earthen Bunds, and to divert some nullah near to ensure their being filled ; one such site is apparently near Sandro, where the Dholpur-Barai Road crosses the stream. The water might be let out and the bed cultivated, or be used for irrigation, as experience may show to be the most profitable ; at present the water all goes to waste.

32. These small village Tals, however good in their way, all put together, would be only a few drops, in comparison with the immense amount of water which annually flows away to waste by the nullahs, which rise in the hills and pass through the State.

33. The State Engineer (Mr. Thorpe) is alive to the importance of doing this, and in his printed report says :—

“The best plan of operations would be to construct a chain of Storage Tanks round the foot of the hills.”

34. This idea is quite sound. The Consulting Engineer (Col. Jacob) has visited some of the sites proposed by Mr. Thorpe, and has made a few suggestions on each project, as noted in Appendix attached. Briefly the projects are Nibi, Seheri, Mohari-Thomati, and Mhar, marked 1, 2, 3 and 4 in the Index Map attached. The Statement (Appendix I) gives details regarding each of these projects.

35. In the Appendix attached will be found notes made at site regarding each of these works.

It would be difficult to find anywhere sites better adapted for storage reservoirs. All have grand basins for storing the water, rock for the escape, splendid stone for any masonry required, and good earth at hand for the earthen portions.

There does not appear to be much valuable land which would be to any extent submerged, and all are situated at the highest part of the State, so that any water stored could command the whole country.

36. Until plans and estimates are prepared it is not possible to say what the cost will be, or how much land will be irrigated, or what returns may fairly be expected ; but the fact remains that the Dholpur State has the opportunity of making some magnificent Storage Tanks, and apparently water sufficient to irrigate a great portion of the State.

I strongly advise the plans and estimates for each of these works being prepared as soon as possible.

37. The State Engineer, Mr. Thorpe, I think, deserves much credit ; the sites alluded to have all been found out by him, and he evidently takes an interest in the subject. He knows the country well, but he has not a sufficient staff at present to enable him to prepare quickly the necessary plans and surveys, so time is lost and water also. He is quite able to supervise the work, as regards survey of 4 or 5 mere Sub-overseers or Surveyors.

It would be to the interest of the State to sanction an increased establishment, or set apart a certain sum for the purpose for the next two or three years.

Whether it will not be more than he can manage properly to carry out these works if sanctioned, in addition to the other works in his charge, remains to be seen. They would require constant supervision.

38. The policy I would suggest is—

- (1) To increase the staff of Surveyors at once (para. 36).
- (2) To repair at once or construct as soon as possible (after plans and estimate are approved for each work) small village Tals, wherever repairs are required, and to make such Tals, where they do not exist and can be made (para. 30).
- (3) To prepare plans and estimates and as soon as they are approved, make long low Bunds on level ground (which can be made at comparatively small cost), in places where the beds can be cultivated (para. 31).
- (4) To put in hand, without delay, surveys for the larger projects of Seheri, Nibi, Mohari-Thomati and Mhar.
- (5) And as soon as these have been approved and funds are available, to carry out one at least of the large works, Seheri perhaps, as being probably the least costly, in addition to the works suggested above in 1, 2 and 3.
- (6) In every case the opinion of the Durbar officials should be invited; it often helps to know what they have to say.

39. In all cases plans and estimates should be prepared and approved before the work is begun, and then a record should be kept showing the details *for each work* :—

- (a) The original cost of the work.
- (b) The contents at each foot in depth.
- (c) The area irrigated annually, whether in the bed or by flow.
- (d) The amount, if any, spent in repairs annually; and
- (e) The returns realized on the outlay annually.

40. If these suggestions are acted upon I feel sure the results will prove how advantageous such a policy really is to the State, if carried out in a liberal and energetic manner. The money so spent will be all spent in the State, and any funds that are available cannot be spent in a better way.

(Sd.) S. S. JACOB, COLONEL,
Consulting Engineer for Irrigation in Rajputana.

December 1902.

APPENDIX I.

Statement showing approximate details of the four large projects for Irrigation in the Dholpur State.

1	2	3	4	5	6	7	8		9
Serial Number.	Number as given in Part II of Irrigation Commission Statement.	Name.	Site.	Rainfall in inches.	Catchment area in square miles.	Amount flowing off catchment area in cubic feet (30 % of rainfall).	Irrigation capacity of column 7 (1,00,000 cubic feet per acre).		REMARKS.
							Acre.	Square miles.	
1	4	Nibi	9 Miles W.S.-W. of Dholpur	28	18.15	353,689,777	3,536	5.5	
2	14	Seheri	8 " East of Bari ...	26	63.10	1,143,608,488	11,436	17.8	
3	18	Thomati-Mohari	3 " S.-W. of Bari ...	23	254.68	4,430,444,348	44,304	69.2	
4	22	Mhar	6 " N.-W. of Bari ...	23	89.66	1,560,422,662	15,604	24.4	
			2 1/2 " South of Baseri			7,488,165,275	74,880	116.9	
			13 " W. of Bari ...						
			3 " S.-W. of Baseri						

A. N. THORPE,
State Engineer.

APPENDIX II.

Note on the Proposed Storage Tank at Nibi.

1. I do not think full advantage has been taken of this splendid site. Apparently a better site would be on a line passing almost east and west through the village of Khanpur, across the nullah where there is a good bed of rock, into the sandhills on the west.

2. Then to follow the general line of the sandhills, which form a natural Bund for some distance ;—crossing the depression west of the sandhills, at the highest points on a north and south line, near the village of Danpura ; using the rock at the west end for an escape, if necessary.

3. Rock crops up on the water shed at the east end also, in the direction of Bishnoda about half a mile distant from Khanpur, and leads one to suppose that a natural escape at this end is possible, but this requires further investigation.

4. If the surplus water can be passed off in this direction, it might perhaps be impounded by a Bund across the low ground east of Sandro and be made good use of.

5. At the east end the line should be taken on the watershed as far as is necessary.

6. The high water level should be fixed, after knowing the contents at different contours, and comparing them with the amount expected to run off the catchment ; so as to enable all the rainfall, if possible, to be stored.

7. The advantages of the Bund being on the line now proposed are:—

- (1) The much larger area and capacity.
- (2) The range of sandhills is taken advantage of, to form a long length of the proposed Bund. If all the gaps between them are properly closed up there is not the slightest fear.
- (3) The land between Khanpur and Nibi would be inundated, and as the water recedes, the land available for cultivation would be much greater.
- (4) The irrigation ducts at starting would be nearer the ground it is proposed to irrigate, *viz.*, the watershed below Garhi for the west Canal, and the watershed below Sandro for the east Canal.
- (5) The rock bed across the nullah on this line seems very good, and will save any deep foundations in the nullah bed, all fissures should be grouted with mortar for about 50 ft. or so.

- (6) If no suitable escapes are found at the east or west end of the proposed Bund ; it would be quite possible to make the centre portion of the Bund with masonry on this rock, and use it as an escape.

8. A core wall of masonry will be required wherever rock is within 10 ft. or so of the surface; and across the portion between the nullah and the sandhills, the wall should be taken well into the ground wherever kunkur is mixed with the soil, as such ground cannot be trusted.

Where the sand is free from gravel, if the bank of sand is made thick enough, and is not allowed to weep away, it may be trusted.

9. There may be some difficulty in getting the water stored, to the ground to be irrigated below Garhi. There are three ways in which this may be done:—

- (1) Either from a sluice on the west side of the present nullah, along the west or left bank; or
- (2) from a sluice on the east of the nullah by an aqueduct, across the nullah, which would practically cease to exist ; or
- (3) by making use of one of the ravines in the sandhills, if levels admit of this, putting a sluice, and core wall across at a suitable place ; taking the wall well into the sandhills on each side to prevent any water getting round.

10. These points and a suitable escape on the rock will need careful consideration.

11. The site is an ideal one for a large storage reservoir. The drainage area of the catchment at this point is about 18 square miles. Taking the rainfall as 28 inches here and the run off at 30 per cent., which on such hard rocky ground, may I think be expected, there would be about $35\frac{1}{2}$ millions cubic feet to be stored ; water which now all annually goes to waste.

12. It is possible that a reservoir here would be able to supply the town of Dholpur with water by gravity, if a water-supply is ever required for the capital, but this can only be ascertained by taking levels.

The accompanying key map illustrates the project.

APPENDIX III.

Note on the Proposed Storage Tonk at Seheri.

1. The site proposed for the Bund is about 2 miles down the nullah north of Seheri, and about $3\frac{1}{2}$ miles South South-west from Barri, near a Nim tree just above the junction of the nullah from Seheri, with the nullah from Nandraoli on the west.

2. The drainage area at this point is about 63 square miles; allowing an average rainfall of 26 inches and 30 per cent. to run off this rocky catchment, which I think may be expected, there would be about 1,143 $\frac{1}{2}$ millions cubic feet of water to be stored, all of which now annually goes to waste.

3. The Bund would be formed across the nullah, from a ridge of high ground near the Nim tree, to the high ground eastward in a north easterly direction, where the length is not great, and the nullah banks 20 ft. deep, so as to entirely close the present nullah.

4. On the east side from this point to Seheri there is a range of sandhills, which forms a natural Bund for about 2 miles.

5. On the west, a low earthen Bund will have to be made on the water shed which divides the Seheri nullah from the nullah on the west. This Bund will have to be taken up to the rocky ground at the foot of the hills, about 500 yards south-west of Amru-ka-pura.

6. This rocky ground will apparently form a natural and safe escape, and appears to be a suitable height for the high water level.

7. It can be raised if necessary; the level of high water level will have to be fixed after the capacity of the proposed reservoir at different levels, is compared with the probable quantity of water, which may be expected from the catchment area, all of which is rocky ground. I should think 30 per cent. might safely be taken.

8. The water stored would be taken away on the right bank, and will probably reach the surface for irrigation in the vicinity of Barri; in any case the large quantity of water stored at the high level and for some feet below it, will very likely admit of a high level Canal. This will have to be ascertained by levels. The whole country slopes away to the eastward, and would be commanded by the water stored here.

9. A masonry core wall would be necessary in the portion across the nullah; and should be carried by steps 10 feet or so below the surface well into the banks on both sides.

10. The site is an ideal one for a storage reservoir. There is a magnificent basin for the spread of the water which would probably

cover about four square miles. There is no good land in the proposed bed, at present it is intersected with nullahs, and of little use, so no compensation I think would be necessary. No village would I think be submerged, and there would be an extensive margin for cultivation as the water recedes.

About two miles of the proposed Bund already exists in the range of sandhills on the east, and for about 800 feet on the north. It is very seldom indeed that a site so favourable is met with for such a large project.

11. I strongly advise the plans and estimate being prepared as soon as possible.

APPENDIX IV.

The villagers at Amrukapura asked for help to prevent the small Tal above the village from leaking. The water is used for the fields below.

The State Engineer knows the circumstances, and his suggestion to put earth on the inner side of the face wall, appears to be all that is necessary.

The villagers were advised to submit an application through the local officials in the usual way.

APPENDIX V.

Note on the Proposed Construction of Storage Reservoirs adjoining Oomree.

The State Engineer (Mr. Thorpe) took me to Nandraoli, Kaolo, and along the Oomree Bund, and showed the site of another Bund it is proposed to make.

As I understand it, the idea is to make a Bund between Nandraoli and Kaolo, with an escape at high water level over the rock eastward, towards Amrukapura, with the option of passing any surplus water, which might be required into the Oomree Bund on the north; and from this, passing any surplus into a proposed new Bund north-west forming a chain of three tanks, the overflow of No. 1 passing into No. 2, and from No. 2 into No. 3.

If this is correct I do not recommend it at present at all events, for the following reasons :—

- (1) The land between Kaolo and Nandraoli is cultivated now, if submerged with about 15 ft. of water (as I understand, is proposed to enable the surplus water to escape over the rock towards Amrukapura), this land would be lost for some time.
- (2) The present Oomree Bund cannot yet be trusted to be filled to the depth originally proposed and overflows as it is.
- (3) Until this water is all used up, the need for more water here is not apparent, although it may be hereafter.

For these reasons it appears to be premature to think of spending money here in making another Bund.

What I would suggest for the present is—

- (1) To make the Oomree Bund perfectly safe ; the section is strong enough, but the soil in some parts appears to be untrustworthy :—

The inner slope is a good deal cut up and longitudinal cracks are visible at the top. I would recommend a masonry or slabstone core wall being put in before next rains in all places where there is any doubt.

- (2) When all doubt has been removed to raise the high water level to the original height proposed or higher.
- (3) Irrigation ducts to be properly laid out and made as soon as possible, to prevent waste of water, and to bring the water to the fields of Zamindars, who I believe will then readily take it.
- (4) When it is found that there is not enough water in this tank to meet the demand, then a small Bund might be made, sufficient to flood the land between Nandraoli and Kaolo, and the surplus be directed to the Oomree Bund. This would benefit the fields between Nandraoli and Kaolo without swamping them entirely. It would cost less and the water or a portion of it would be stored in the Oomree Talao instead of the first one.

At the same time the nullah which it is proposed to Bund brings a good deal of water, and if it has not been already done, it would be worth while to see if a site for bunding up, or diverting to Oomree some of its water cannot be found higher up, so as to irrigate the land between Nandraoli and Kaolo instead of flooding it.

It would be a good thing I think also to make a raised roadway from the Bund across to the nearest high ground above high water level to

divide this large sheet of water into two parts. At present anyone wishing to cross has to go round one end or the other, a distance of a mile or more at least ; also if any breach occurs in one part there is danger of all the water being lost.

The water when one part is filled might be allowed to pass over the natural ground at high water level into the other portion.

This is not an absolutely necessary work, but in a long bund of this sort is a good precaution, if funds are available, or as a Famine Relief Work.

APPENDIX VI.

Note on the Proposed Storage Reservoir on the River Parbati at Thomati-Mohari.

About six miles north of Barri, where the River Parbati passes between the villages of Mohari and Thomati, is a good site for a large storage reservoir.

The high ground on both sides approaches here. There is rock in the bed and on each side.

In the bed of the river are the remains of an old Badshahi Bund, a mass of solid masonry on rock about 350 feet long, 50 feet thick, and 10 feet high ; the river in flood passes round each end of it, and in heavy floods is said to pass over it about 6 feet deep. No water was flowing at this date, 22nd November 1902.

The rock at the north end is of poor quality, shaley red sandstone, untrustworthy : at the south end rock is visible in the bed only. About 1,200 feet lower down, the river falls from this ledge of rock to a much lower level.

The section of the broken masonry does not lead one to suppose that the Mahomedans had the intention of making a high dam here, or of stopping all the water, probably a weir only to impound some water and to form a good crossing.

The site appears a good one for a large bund ; it would be a grand but expensive work. It appears to be the last place on the course of the River Parbati, where rocky ground closes in the river on both sides. The gorge here at a height of about 50 or 60 feet would probably be about 2,500 feet across.

The site for a new bund would be at the north end of the rocks on which the village of Thomati is situated, across to a rocky mound opposite, known as the site of the Mohari Quarries. At both places the

sandstone rock is of good character, and is now quarried for building purposes. It is probable that this ridge stretches right across; this would have to be ascertained.

It would also probably be necessary to make an earthen shield bund, parallel to the river from the Mohari end, the north end, to the village of Barri, about a mile higher up, on the north bank, to prevent water passing off to the north.

There appears to be a site for an escape in a saddle in the range of rocky hills south-west of the village of Beranpur. This requires examination to see if the rock is sound here and could be trusted.

The basin is a grand one for the storage of water, and a lake could apparently be formed here four or five square miles in area. The whole country slopes away to the east to the borders of the State, a distance of about 25 miles. The soil is good, the surface unbroken by ravines, it is well populated, and irrigation would be certain.

A little silt might come, but I do not think it would in any way interfere with the usefulness of the work, as the catchment area is so good.

Until proper surveys have been carried out it is impossible to say what the cost of the project would be, or what land would be submerged, whether any compensation would be necessary, and how much land would be irrigated, and what returns might be fairly expected.

It may be beyond the resources of the State to attempt such a grand work for some time to come, but I strongly advise plans and estimates being prepared.

The catchment area of the river at this point is about 255 square miles. Allowing an average rainfall of 23 inches and 3 cents of this to run off, which is not improbable from such a rocky catchment, there would be about 4,430 millions cubic feet of water available for storage. At present this all goes to waste, not once but annually. If it can be stored and used for irrigation it would practically ensure the area commanded, about 60 square miles, from want of water.

At the same time it will be advisable to examine the course of the River Parbati from near its source, before any decision is formed, to see if any better sites exist higher up, and if so, whether it would be possible to make use of the water which could be stored.

APPENDIX VII.

Note on the Proposed Storage Tank at Mhar.

This is a site which has been suggested by Mr. Thorpe, the State Engineer, as a good site for a storage reservoir.

The drainage area at this point is about 89 square miles. Allowing 23 inches as the average annual rainfall, and 30 per cent. as the run off, there would be about 1,560 millions cubic feet available for storage, which now all goes to waste.

The site is an opening in a range of hills about 500 yards wide. On the north-east end the rock is visible. On the west side of the nullah there is a vertical bank about 40 feet high of hard soil covered with sand and coarse jungle; beyond this is another range of rock, a continuation apparently of the range at the north-east end of the proposed line.

The soil near the river is rich and good.

The river passes close under the high bank. At present there is a pool of still water about 5 feet deep extending above and below the site for about a mile, caused by a ledge of rock lower down, over which the bed falls to a lower depth.

It would be necessary to cut this through and to drain off the water, or there would be difficulty in getting in the foundations of the core wall at the proposed site.

Although the soil is good for an earthen bund I would suggest a masonry core wall, founded on rock if possible, in the main dam, or there may be leakage, or perhaps a breach, owing to the probable proximity of the rock below the surface.

The basin for the storage of the water is a good one. There is one village, Oomreekapura, in the bed; whether it would be submerged will depend upon the height of the high water level, which can only be determined after surveys have been made, and the capacity of the basin at different heights is compared with the probable amount of water expected.

There is also some cultivated ground, which will have to be taken into account.

The masonry core wall would have to be taken some distance into the sandhills to prevent any possibility of the water getting round. The sandhills may be safely used as a portion of the bund, which might be taken on to the rocky ridge on the south-west, where, if the levels admit, an escape might be found as well as at the north-east end.

The land which it is proposed to irrigate is situated on both sides of the nullah; how much of this can be commanded by this reservoir remains to be seen. Until plans and estimates are prepared it is impossible to say more. Owing to the rocky character of the ground beyond

Pura to the east, and the sparse population here, I fear the returns in this direction would be disappointing; only the land east of Mhar on both sides of the nullah for about $1\frac{1}{2}$ miles or so may perhaps be irrigable. Some wells also exist.

These are matters which will require careful consideration before the scheme is sanctioned.

The ducts should be surveyed, and the amount of land now cultivated and culturable should be ascertained. Until this is done it is difficult to say how much will be irrigated, or whether there will be a fair return upon the outlay, but the site is a good one, and I would suggest plans and estimate being prepared when Surveyors are available.

APPENDIX VIII.

Note on the Site of an old Bund at Tajpur.

Near this place is an old broken bund; there is a flat basin inside, about a mile square, which is being cut up by the flow of the water from the surface in the rains.

If the water which now cuts up this ground and goes to waste was impounded at the rocky gorge close to Tajpur, so as to inundate this basin, it would be a good thing.

I do not think it would be safe to trust the old bund, the work in it is not good; but a small masonry bund across the rocky bed about 150 feet or so lower down might be easily made.

It is doubtful if there would be any direct irrigation unless the levels will admit of the water reaching the ground north or north-east of Tajpur, but the cultivation of the bed, after the water was let out, ought to pay well.

I would recommend plans and estimate being prepared.

APPENDIX IX.

New Bund proposed near Hosainpur.

At Hosainpur, Mr. Thorpe, the State Engineer, showed me the site for a bund he proposes to make across a nullah, which passes west of the village. A small tank exists near the village, and the surplus water of the tank proposed might be made to pass into this if desired.

The site appears a good one, there is a good catchment, a good basin for storage, and good land below.

If the plans and estimate have not yet been prepared they might be done as soon as possible.

NOTE ON IRRIGATION
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NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION ON THE RIVER PARBATI IN THE DHOLPUR STATE.

On the 15th March 1905 the Consulting Engineer (Colonel Sir S. Jacob) went to Khanpur with the State Engineer (Mr. A. N. Thorpe). The next morning they visited Seheri, where a large storage tank, now called "Ram Sagar," after the present Maharaj Rana of Dholpur, is being carried out.

This is one of the large storage tanks suggested in November 1902. It is satisfactory to see the progress which has been made, and the excellent way in which the work is being carried out under Mr. Thorpe's supervision.

It is important that the escape should be on rock. To ensure this it is suggested that the bund be extended at the west end. The advantages obtained in the extra water which would be stored, and the less fear of any land being cut up by the overflow, are well worth the small extra cost.

2. From here they went *via* Oomree to Dhimri, about 7 miles west to north-west of Bari, and in the evening inspected the Parbati River and the site of a proposed storage reservoir on the river just above Barai.

The next day they rode up the river, inspecting sites on the river at Kuragaon and Khurdia, and encamped at Khannot. In the evening they went still higher up the river as far as Mandasil.

3. The following Note by Mr. Thorpe, on Irrigation from the River Parbati, dated 20th March 1905, will explain his ideas:—

Preliminary Report on the "Parbati River" Irrigation Project.

"1. The catchment of the Parbati River, where it leaves the hills near Thamoti-Mohari, is 340 square miles, which, assuming the rainfall at 24 inches, and the "run-off" at 30 per cent., would give some 5,700 million cubic feet of water as available for storage.

"2. The survey of a dam at this site was carried out during the season 1903-04, which proved that a dam with the weir crest 70 feet above the river bed would give a storage capacity of 5,000 m. c. ft., but an examination of the river bed for foundations showed that it was composed of a most unreliable shale, which could be traced to a depth of 18 feet without any change in its character. Another objection against a dam at this point was that this highly cultivated village of Barai would be permanently submerged and an ancient temple destroyed.

"3. These considerations led to the abandonment of the site and a systematic examination of the upper reaches of the river with a view to obtaining sounder sites; and if no sufficiently large basin could be found, the selection of several smaller ones to impound the whole of the available water. One consideration had, however, to be kept in view, namely—that the best land for irrigation lay on the large plain to the north of the river, and to the east of Baseri, and that, wherever the storage might be situated the canal alignment should eventually command this plain.

"4. The examination of the upper reaches of the river showed that the river bed consisted of a number of "giant steps," level reaches, of ten miles long, being succeeded by sharp short falls.

"5. The Parbati River, rising in the Karauli State, enters Dholpur through a deep gorge near Bilonie, from whence to Chandpur the river continues to rush down its rocky bed at great velocity, owing to the steep grade of its bed. At Chandpur the first of the "steps" occur, followed by a short reach and a further drop of 8 feet. At Baragaon another drop of 10 feet occurs, followed by a level stretch of 3 miles, until the Mandasil Falls are reached. At this point a sheer drop of 15 feet is followed by a further fall of 25 feet in half a mile. Another level stretch of one and a half miles ends at Khurdia, where a rapid of half a mile lowers the river bed another 23 feet. The succeeding reach of 6 miles brings us to Liloti, where a drop of 15 feet in 300 yards is followed by a one mile reach, ending with the great rock barrier at Kuragaon, where with a leap of 35 feet in a mile, the river enters a maze of ravines some eight miles long, ending at Banora, with a gently-falling bed from there to Barai, where a drop of 3 feet in 100 yards occurs. From Barai to Thamoti the level is maintained, but below the last-named the river bounds out from the hills at immense velocity, down a steep rock with a slope of 40 feet to the mile, the total drop being some 60 feet.

"6. During its course through the hills the river is joined by two large tributaries, one on each bank. From the south the Kharrair Nadi leaves the very rugged hills near Domai, and proceeds on a fairly level bed through highly-cultivated country to Sirmuttra, where a fall of 30 feet in one mile brings it to the river bed level a short distance above Khurdia.

"7. From the north the Sairni River enters from Karauli through the natural basin of Mahar, and continues on the level to Barcunjara, whence a fall of 40 feet in three miles discharges it into the Parbati near, but slightly below, Kuragaon.

"8. From an irrigation point of view the most favourable sites for storage tanks must necessarily be immediately above one of the falls, which, composed as they are of rock barriers, secure that most necessary consideration, a good foundation for a dam. In addition to this these points must obviously give the longest stretch of level bed, and therefore the greatest storage capacity, and lastly, being immediately above a fall, the greatest command of the irrigable area below.

"9. The above considerations therefore confine the choice of sites to five, viz:—

	Catchment Area. Square Miles.	Rainfall in Inches.	Water available for Storage. Million Cubic Feet.
(a) Mandasil	196.24*	24	1,773
(b) Khurdia	140.74*	24	2,358
(c) Kuragaon	196.10*	24	3,271
(d) Barai	240.60*	24	4,030
NORTH BRANCH			
(e) Mahar	89.66	23	1,560

* Excluding the C.A. of Mahar.

"Site (a) Mandasil was rejected on account of the highly-cultivated state of the country, and the small basin which a casual inspection showed could not hold the available "run-off" without an unduly high dam.

"Site (b) Khurdia has been surveyed and found a fairly favourable site where a dam 61 feet high to weir crest would store the required quantity of water. The objections to this site are, the very sandy bed, the broken ground on the south bank through which the irrigation canal must necessarily lead, and the cross drainage which the canal must encounter. The broken ground extends some 1,000 yards, after which a large level plain is encountered. A small amount of cultivation in Khurdia village will be permanently submerged, but as the total rental of that village is only Rs. 2,000 per annum this is a minor consideration. Some good land in Mandasil village will be temporarily submerged.

"Site (c) Kuragaon was rejected on account of the sand-hills unduly confining the basin, and the absence of irrigable land below.

"Site (d) Barai, although not an ideal site, is a good one, with fairly good foundations across the river bed. It is extremely favourable for the canal line, which would take off from the north bank and command the whole of the Baseri Plain. With a weir crest of 47 feet above river bed level it would have a capacity of 2,374 m.c.ft. With a dam 71 feet high at weir crest the capacity would be 11,220 m.c.ft, which for a sand dam would appear somewhat hazardous.

"Site (e) Mahar has been surveyed, and with a weir crest 43 feet above river level would contain 2,269 m.c.ft. The basin is an ideal one, but some valuable land would be submerged, and the irrigable area below is somewhat limited.

"10. Taking all considerations into account it would appear that the best Project for utilising the vast quantity of water now flowing away unused to the sea would be that in which three large storage tanks are involved; the two high level ones irrigating all available land within a reasonable distance and discharging their surplus water down the river bed into the lower tank, which should command the vast Baseri Plain.

"11. Pending the completion of the detailed estimates and the comparison of cost, the following would appear to be the most favourable sites for a Project of this class, viz :—

	Catchment Area Square Miles.	Storage Capacity. Million Cubic Feet.
(1) Khurdia	140·74	2,358
(2) Mahar	89·66	2,269
(3) Baria 330·26	99·86	2,374
Combined... ..	330·26	7,001

In this Project Nos. 1 and 2 would discharge their surplus waters into No 3, and the whole Project would have an irrigation capacity of 70,000 acres."

4. The upper parts of the River Parbati, as Mr. Thorpe states, consist of level reaches, succeeded by rocky falls; the most favourable sites for dealing with the river are naturally just above each of these falls, because at such places :—

- (1) There is a greater command of the country below.
- (2) There is no difficulty about foundations.
- (3) There is plenty of material at hand from the rock close by.
- (4) There is the best storage capacity from the long level stretch of river bed, above the fall.

5. There are five such sites on the River Parbati at—

- (1) Mandasil.
- (2) Khurdia.
- (3) Kuragaon.
- (4) Barai.
- (5) Thamoti.

And one on the north branch at Mahar.

Regarding—

(1) *Mandasil*.—I agree with Mr. Thorpe for rejecting this, for the reasons he states.

Regarding—

(2) *Khurdia*.—The objections to this site are the sandy nature of the proposed reservoir bed; the broken ground and cross drainage on the south bank through which the canal would have to pass; the rocky range which somewhat confines the basin and the scope of any canal on the left bank for some distance.

At the same time the site has advantages. There is good rock for the foundations in the bed of the river; there is a good site for the escape on the left bank on rock at the north end; there is any amount of good material—rock, sand and kunkar near for making the dam; a great

portion of the bund on the right bank could be made of sand ; there would be little land of any value submerged ; a great part of the catchment area is rock, and any reservoir would quickly fill every year ; the high level at which the water would be stored ought to enable it to command a large area.

The sand in the bed of the proposed reservoir may cause some silting up, but would not, I think, give much trouble, for it would take many years to silt up the river bed to its banks, and the bed could be cultivated as the water receded.

If any storage reservoir is made here, it will be advisable to provide large sluices for scouring in case of need, and also to allow water to flow freely down the river to fill any other reservoirs which may be made hereafter. This is important.

The canal line was not marked out, but I understand the country has been levelled and the general line has been fixed.

Regarding—

(3) *Kuragaon*.—Mr. Thorpe states : “ This was rejected on account of the sand-hills unduly confining the basin, and the absence of irrigable land below.”

There is such a good crossing of the river here on solid rock, “ a great rock barrier with a leap of 35 feet in a mile,” and such a profusion of rock lying about, that it seems to be an ideal place for a masonry dam or weir, as far as the site is concerned.

No work or expense would be required on the left bank ; there is a natural bund of rock on this side, and it seemed that an earthen bund might be made on the right bank, across to Bhaonpura, or the high ground in this direction, and if this is feasible, there would apparently be a good storage basin.

At the same time it is quite possible the levels will not admit of this ; or too much cultivated land may be submerged ; or, as Mr. Thorpe thinks, it might be impossible to reach irrigable land below. It is true there is any amount of good land eastward on the Baseri plain ; to reach this, however, it would be necessary to cross the Sairni nullah ; to reach good land on the right bank would also present great difficulties ; any canal on either bank would have to cross a great deal of broken ground, and may prove too costly, even if possible.

The site, however, appears such a good one that it is suggested levels be taken, and if found to be at all feasible, proper plans and estimates be prepared.

Regarding—

(4) *Barai*.—The basin is large, there is rock visible in the river bed, and Mr. Thorpe states rock is found right across, and that an escape on rock can be made somewhere at the east end.

There would be less difficulty, it is true, in taking a canal off from here than at other sites ; and a canal would command a great part of the Baseri plain.

It is not, however, an ideal site, and the plans and estimates do not appear to be fully prepared. Without knowing more and comparing the plans and estimates with alternative Projects I do not feel justified in giving a decided opinion on this scheme.

Regarding—

(5) *Thamoti*.—It will be remembered, perhaps, that a Project was proposed by the State Engineer (Mr. Thorpe) in November 1902 for making a large storage reservoir on this River Parbati, at a place called Thamoti—Mohari (Site No. 5), about 2 miles lower down than Site No. 4. No plans and estimate had been prepared, but the Consulting Engineer, while then approving of this site, suggested that before any decision was formed, it would be advisable to examine the course of the river from its source to see if any better sites exist higher up; and if so, if it would be possible to make use of the water which could be stored.

Mr. Thorpe now reports that an examination of the river bed here for foundations showed that it was composed of a most unreliable shale, which could be traced to a depth of 18 feet without any change in character, and that the highly-cultivated village of Barni would be permanently submerged, and an old temple destroyed, and for these reasons this site was abandoned.

Regarding—

(6) *Mahar*.—Mr. Thorpe states that the project has been surveyed, and that a weir with a crest 43 feet above river level would contain 2,269 million cubic feet, but some valuable land would be submerged, and that the irrigable area below is somewhat limited; the quantity in either case is not stated. The remarks made by the Consulting Engineer, therefore, in December 1902 on this Project still hold good. It is unnecessary to repeat them here.

6. The above remarks show how the matter now stands. The River Parbati is the main artery, as it were, of the Dholpur State, and in the interests of the State the water of this river should *all* be stored, if it is possible to store it. It rises in the highest part of the State: it has a fine catchment of a range of hills of sand-stone rock, which ensure a good flow-off; it has ledges of rock in places where any amount of good material is available for making dams; above its natural falls it has a good command of the country; there is any amount of good land below (the whole State of Dholpur in fact) to be irrigated, almost every drop of water could be utilised, and all now goes to waste.

It would be difficult to find conditions more favourable for Irrigation.

The real difficulty is how to make the best use of these great natural advantages.

7. The two ways of dealing with the river appear to be :—

- (1) To make storage reservoirs on the river, or its tributaries; or,
- (2) By permanent weirs on the river, above some of the falls, to divert the water to where it can be stored elsewhere, and used as required.

Although no places for doing (2) have been pointed out, yet it is well to bear the possibility in mind. During the months that irrigation is not required and water is flowing in the river the canals might be used, perhaps, to convey any surplus water to storage tanks elsewhere, if suitable places exist.

Large storage tanks have many advantages over small tanks ; storage reservoirs, therefore, should be as large as circumstances permit. The higher up these storage tanks can be made, as a general rule, the greater command they will have, and being on the same river the higher ones can be made to supplement those below.

8. Not a drop of water should be allowed to go to waste. This is the great principle which should be kept steadily in view. There is no need to be in a hurry. There are other good Projects which can be taken up. In the meantime too much trouble cannot be taken to thrash out alternative Projects and compare results.

9. The catchment of the River Parbati near Thamoti is about 340 square miles, and assuming the run-off as 30 per cent. of an average annual rainfall of 24 inches, about 6,000 million cubic feet of water is available for storage, sufficient to irrigate about 60,000 acres, and every year this is passing away unused.

10. It is better not to attempt the storage of this in one place, but to distribute it over three or four places, and although it is easy to fix upon the most likely places (as Mr. Thorpe has done) it is difficult to say which is the best to take up first, until each Project has been properly prepared and it is possible to compare one with the other. Other things being equal the higher up the better, and as good land gives a better return than land of an inferior quality, the Project which would command the best land should be preferred.

11. In the meantime further investigation is advisable ; the plans and estimates of alternative Projects should be carefully prepared ; the land which can be irrigated from each should be marked out ; the anticipated returns from each Project should be carefully estimated, the results compared and the opinion of the Revenue Officials invited.

12. It is clear the River Parbati might be made a source of great benefit to the State ; at present it is entirely unused ; and the best way of storing all this water I consider to be the greatest and most important work that the State can undertake.

S. S. JACOB, COL.,
Consulting Engineer for Irrigation.

NOTE ON IRRIGATION
"
IN THE
DHOLPUR STATE.

1902.

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Map of the Dholpur State showing the above sites.

NOTE ON IRRIGATION IN THE DHOLPUR STATE, 1902.

1. "The greatest length of the State is 76 mile from east to west the average breadth, 16 from north to south. The superficial area is 1,193 square miles."

2. "Starting from the alluvial plain near Dholpur, which is 600 feet above mean sea level, a range of hills runs westward paralld to, and from 3 to 5 miles distant from the River Chambal; from this other ranges spread out until at the western border they occupy the whole breadth of the State."

3. "They are chiefly of a red sandstone formation, and their rocky surfaces are for the most part bare even of trees and shrubs."

4. "A peculiar feature of the State is the vast number of ravines: which though they abound near every nullah are particularly developed near the Chambal." "They are yearly extending and occupy many square miles of the country."

5. "Only one river rises in the State, namely, the Parbati which passes through the Barri, Baseri and Kolasi Perganas, into the Banganga, in the Agra District." "It is fed by numerous small streams rising in the adjacent range of hills, and the characteristics of all are very similar. The beds are mostly rocky, and the banks lined with ravines or a sandy unfertile soil." "Although pools of water are found in the bed of the Parbati; the Parbati river is not perennial, and its affluents are dry in the cold and hot weather, and only full after a heavy fall in the rains."

6. The total area of the State is put down at 7,76,237 acres.

The total area of Khalsa land 5,78,679 acres or 904 square miles; of this quantity hills, ravines and barren ground occupy 2,33,685 acres or 365 square miles. Mafi or Jagir plots 15,097 acres or 23 square mile-. Cultivated 2,45,691 acres or 384 square miles. Culturable 84,206 acres or 131 square miles.

7. The density of population per square mile for the total area of the State, according to the last census returns, is stated to be 233, but the large area taken up by ravines and bare hills has to be taken into account.

8. The population of the State is given as :—

Males	...	...	1,57,004
Females	...	...	1,22,720
Total			2,79,724

The Musalmans numbered only 17,389, and inhabit chiefly Dholpur and Bari Towns.

9. There are 43 Jagir villages with a total area of 31,224 acres.

There are 39 Tankidar villages, 32 belonging to the Rao of Sir Muttra, and 7 to the Rao of Rijhanni, comprising altogether about 1,27,052 acres.

10. The Khalsa villages number 419, covering 5,78,679 acres, or 75.3 per cent. of the entire area of the State.

11. *Rainfall*.—Average for the State is said to be about 25 inches.

12. *Means of Irrigation*.—"Tanks irrigate a very small area." From State Tanks, the area is stated to be about 2,041 acres.

"The first attempts appear to have been made in the times of the Mohammedan Emperors. The best example exists at Khanpur from which some 350 acres are now irrigated."

"Since that period, with the exception of repairs to a few Tals, nothing has been done owing to the financial condition of the State, until 1896-97, when the necessity of employing famine labour, caused the Tals of Nurpura, Oomree, Sheikhpur and some smaller ones to be constructed on hurriedly collected data."

13. The amount spent is stated to be in Khalsa land, Rs. 73,932
 " " " (estimated to be) in Jagir " " 33,000
 " " advanced in Takavi during the
 same period is said to be 29,245

14. *Wells*.—The chief source of irrigation is wells.

It is stated that these are now :—

	Total.
Masonry Wells in Khalsa land 4,501	} 4,877
" " " Jagir " 376	
Kachcha " " Khalsa " 8,166	} 8,169
" " " Jagir " 3	

Kachcha wells are sometimes lined with munj or sarpatia grass, a ring of rope about four inches thick.

15. The average area irrigated per run, is stated to be about 4.1 acres; and the cost per acre about one rupee for one watering.

16. The depth at which water is found varies, except at Rajakhera, where the water is from 60 to 80 feet deep, and sometimes more; water is no where very deep. In Barri, Baseri and Kolasi Perganas it is usually found at about 30 feet, rarely more, sometimes less.

17. The total area under cultivation is stated to be now :—

	Acres.
In average years—In Khalsa	2,56,986
" " " Jagir	45,382
Total ...	3,02,368

of this quantity, the area irrigated from wells is	Acres.	Acres.
stated to be in Khalsa	...	83,343
Estimated area in Jagir and Mafi...	7,906	
The total culturable land in Khalsa	3,45,910}	4,11,213
" " " " " Jagir	65,803}	
" " unculturable " " Khalsa	2,34,863}	3,52,249
" " " " " Jagir	1,17,386}	

18. There are no Jheels or depressions not already used which can be drained and cultivated ; all such places are said to be now cultivated.

19. Thirty-one Tanks, as Irrigation Works have been proposed by the State Engineer, Mr. A. N. Thorpe, who evidently takes an interest in the subject ; but only four of these have been estimated, and these will probably need revision.

20. The larger projects Nibi, Seheri, Thomati- Mohari and Mhar, have been inspected by the Consulting Engineer in company with Mr. Thorpe. Notes regarding each are attached. (See Appendix.)

21. The people certainly appreciate the value of water, judging from the many small Tals which are met with ; but they seem to prefer to let out the water for the cultivation of the bed ; probably this is owing to the ease with which it is done, and because they have not had enough water, to irrigate any quantity of land by flow.

If they could have a canal or supply for any large area, they would no doubt see the value of such irrigation and appreciate it.

22. The whole country slopes from the rocky range of hills on the west and south-west towards the east and north-east.

"Owing to the slope of the catchment and the friable nature of the soil, all the rivers and nullahs have cut their beds deep, much below the surface level, and the smallest nullahs are surrounded by ravines, which would render the cost of any attempts at utilising their waters by flooding prohibitive."

23. The bare rocky range of hills at the highest part of the State is in fact a source of danger as well as an advantage to the State. The danger consists in the large share of rainfall which runs off (50 per cent., more or less is stated by Mr. Thorpe,) and the velocity with which it flows, is so great that only rock can withstand it, and unless this is counteracted in some way, or the water cuts down to rock it is only a question of time, though perhaps a long time, as to the extent of the ravines.

24. On the other hand, as this range of hills is at the highest part, the extreme end and side of the State, any water stored here, would command all the land to the eastward, to the boundaries of the State.

Nature could not have arranged better for the interest of Dholpur. If only good use is made of the opportunities afforded, enough water falls at the highest part, to irrigate the greater part of the State, and make it absolutely safe against famine.

25. "There are no perennial streams flowing through the State with the exception of the River Chambal, which forms the southern boundary of the State; but its bed is about 130 ft. below the level of the surrounding country, and it is bounded by ravines spreading out to the foot of the hills, which rise some 500 ft. above the plain." "Any idea of utilising this river may therefore be discarded."

26. The only means for promoting irrigation are by *storage tanks* and *wells*.

Wells may no doubt be profitably made in many places, and arrangements for making them can be made by the civil authorities, as circumstances admit, without professional help.

Storage Tanks.—It would be difficult to find a State better adapted for making Storage Tanks.

Almost every depression near a village, can be made use of. Many examples exist already, where the villagers have thrown up small banks of earth, generally faced with stone, where a little water is collected in the rains and the bed, which would not exist, but for this small Bund, is cultivated afterwards, and perhaps a patch below the Bund also.

28. The rocky nature of the ground ensures the Tal filling, even with a small fall of rain, and the percolation from the water stored, keeps the village well supplied, when it would otherwise be dry.

29. There are many places too no doubt where the valley, if long enough might be terraced and two or more Tals be made, and the water be sufficient to fill one Tal after another.

The construction is so simple and so well adapted to the wants and capabilities of the people that such works are deservedly popular; such works are specially suitable too for Relief Works, as they would spread relief over a large area, would be near the villages, and so keep people from leaving their homes, and would not require much supervision, beyond the general alignment and levels; and the construction of proper escapes, from want of which some Tals have been breached.

30. I would strongly advise this class of work being properly arranged for; every village should be reported on, if it has such a Tal, if it is in proper repair? if it has not, whether it is possible to make any small work of this sort?

The State Engineer could then prepare plans and estimate for each Pargana, and the works can be carried out gradually, or be ready in case of need.

Mr. Thorpe the State Engineer is, I believe, taking steps to repair all such Tals where possible, but there is much to be done.

31. In some places it may be possible to make long low earthen Bunds, and to divert some nullah near to ensure their being filled; one such site is apparently near Sandro, where the Dholpur-Barai Road crosses the stream. The water might be let out and the bed cultivated, or be used for irrigation, as experience may show to be the most profitable; at present the water all goes to waste.

32. These small village Tals, however good in their way, all put together, would be only a few drops, in comparison with the immense amount of water which annually flows away to waste by the nullahs, which rise in the hills and pass through the State.

33. The State Engineer (Mr. Thorpe) is alive to the importance of doing this, and in his printed report says:—

“The best plan of operations would be to construct a chain of Storage Tanks round the foot of the hills.”

34. This idea is quite sound. The Consulting Engineer (Col. Jacob) has visited some of the sites proposed by Mr. Thorpe, and has made a few suggestions on each project, as noted in Appendix attached. Briefly the projects are Nibi, Seheri, Mohari-Thomati, and Mhar, marked 1, 2, 3 and 4 in the Index Map attached. The Statement (Appendix I) gives details regarding each of these projects.

35. In the Appendix attached will be found notes made at site regarding each of these works.

It would be difficult to find anywhere sites better adapted for storage reservoirs. All have grand basins for storing the water, rock for the escape, splendid stone for any masonry required, and good earth at hand for the earthen portions.

There does not appear to be much valuable land which would be to any extent submerged, and all are situated at the highest part of the State, so that any water stored could command the whole country.

36. Until plans and estimates are prepared it is not possible to say what the cost will be, or how much land will be irrigated, or what returns may fairly be expected; but the fact remains that the Dholpur State has the opportunity of making some magnificent Storage Tanks, and apparently water sufficient to irrigate a great portion of the State.

I strongly advise the plans and estimates for each of these works being prepared as soon as possible.

37. The State Engineer, Mr. Thorpe, I think, deserves much credit; the sites alluded to have all been found out by him, and he evidently takes an interest in the subject. He knows the country well, but he has not a sufficient staff at present to enable him to prepare quickly the necessary plans and surveys, so time is lost and water also. He is quite able to supervise the work, as regards survey of 4 or 5 mere Sub-overseers or Surveyors.

It would be to the interest of the State to sanction an increased establishment, or set apart a certain sum for the purpose for the next two or three years.

Whether it will not be more than he can manage properly to carry out these works if sanctioned, in addition to the other works in his charge, remains to be seen. They would require constant supervision.

38. The policy I would suggest is—

- (1) To increase the staff of Surveyors at once (para. 36).
- (2) To repair at once or construct as soon as possible (after plans and estimate are approved for each work) small village Tals, wherever repairs are required, and to make such Tals, where they do not exist and can be made (para. 30).
- (3) To prepare plans and estimates and as soon as they are approved, make long low Bunds on level ground (which can be made at comparatively small cost), in places where the beds can be cultivated (para. 31).
- (4) To put in hand, without delay, surveys for the larger projects of Seheri, Nibi, Mohari-Thomati and Mhar.
- (5) And as soon as these have been approved and funds are available, to carry out one at least of the large works, Seheri perhaps, as being probably the least costly, in addition to the works suggested above in 1, 2 and 3.
- (6) In every case the opinion of the Durbar officials should be invited; it often helps to know what they have to say.

39. In all cases plans and estimates should be prepared and approved before the work is begun, and then a record should be kept showing the details *for each work* :—

- (a) The original cost of the work.
- (b) The contents at each foot in depth.
- (c) The area irrigated annually, whether in the bed or by flow.
- (d) The amount, if any, spent in repairs annually; and
- (e) The returns realized on the outlay annually.

40. If these suggestions are acted upon I feel sure the results will prove how advantageous such a policy really is to the State, if carried out in a liberal and energetic manner. The money so spent will be all spent in the State, and any funds that are available cannot be spent in a better way.

(Sd.) S. S. JACOB, COLONEL,
December 1902. Consulting Engineer for Irrigation in Rajputana.

APPENDIX I.

Statement showing approximate details of the four large projects for Irrigation in the Dholpur State.

1	2	3	4	5	6	7	8		9
Serial Number.	Number as given in Part II of Irrigation Commission Statement.	Name.	Site.	Rainfall in inches.	Catchment area in square miles.	Amount flowing off catchment area in cubic feet (30 % of rainfall).	Irrigation capacity of column 7 (1,00,000 cubic feet per acre).		REMARKS.
							Acres.	Square miles.	
1	4	Nibi	9 Miles W.S.-W. of Dholpur	28	18.15	353,689,777	3,536	5.5	
2	14	Seheri	8 " East of Bari ...	26	63.10	1,143,608,488	11,436	17.8	
3	18	Thomati-Mohari	3 " S.-W. of Bari ...	23	254.68	4,430,444,348	44,304	69.2	
4	22	Mhar	6 " N.-W. of Bari ...	23	89.66	1,560,422,662	15,604	24.4	
			2½ " South of Baseri			7,488,165,275	74,880	116.9	
			13 " W. of Bari ...						
			3 " S.-W. of Baseri						

A. N. THORPE,
State Engineer.

APPENDIX II.

Note on the Proposed Storage Tank at Nibi.

1. I do not think full advantage has been taken of this splendid site. Apparently a better site would be on a line passing almost east and west through the village of Khanpur, across the nullah where there is a good bed of rock, into the sandhills on the west.

2. Then to follow the general line of the sandhills, which form a natural Bund for some distance ;—crossing the depression west of the sandhills, at the highest points on a north and south line, near the village of Daupura ; using the rock at the west end for an escape, if necessary.

3. Rock crops up on the water shed at the east end also, in the direction of Bishnoda about half a mile distant from Khanpur, and leads one to suppose that a natural escape at this end is possible, but this requires further investigation.

4. If the surplus water can be passed off in this direction, it might perhaps be impounded by a Bund across the low ground east of Sandro and be made good use of.

5. At the east end the line should be taken on the watershed as far as is necessary.

6. The high water level should be fixed, after knowing the contents at different contours, and comparing them with the amount expected to run off the catchment ; so as to enable all the rainfall, if possible, to be stored.

7. The advantages of the Bund being on the line now proposed are:—

- (1) The much larger area and capacity.
- (2) The range of sandhills is taken advantage of, to form a long length of the proposed Bund. If all the gaps between them are properly closed up there is not the slightest fear.
- (3) The land between Khanpur and Nibi would be inundated, and as the water recedes, the land available for cultivation would be much greater.
- (4) The irrigation ducts at starting would be nearer the ground it is proposed to irrigate, *viz.*, the watershed below Garhi for the west Canal, and the watershed below Sandro for the east Canal.
- (5) The rock bed across the nullah on this line seems very good, and will save any deep foundations in the nullah bed, all fissures should be grouted with mortar for about 50 ft. or so.

- (6) If no suitable escapes are found at the east or west end of the proposed Bund ; it would be quite possible to make the centre portion of the Bund with masonry on this rock, and use it as an escape.

8. A core wall of masonry will be required wherever rock is within 10 ft. or so of the surface; and across the portion between the nullah and the sandhills, the wall should be taken well into the ground wherever kunkur is mixed with the soil, as such ground cannot be trusted.

Where the sand is free from gravel, if the bank of sand is made thick enough, and is not allowed to wear away, it may be trusted.

9. There may be some difficulty in getting the water stored, to the ground to be irrigated below Garhi. There are three ways in which this may be done:—

- (1) Either from a sluice on the west side of the present nullah, along the west or left bank; or
- (2) from a sluice on the east of the nullah by an aqueduct, across the nullah, which would practically cease to exist ; or
- (3) by making use of one of the ravines in the sandhills, if levels admit of this, putting a sluice, and core wall across at a suitable place ; taking the wall well into the sandhills on each side to prevent any water getting round.

10. These points and a suitable escape on the rock will need careful consideration.

11. The site is an ideal one for a large storage reservoir. The drainage area of the catchment at this point is about 18 square miles. Taking the rainfall as 28 inches here and the run off at 30 per cent., which on such hard rocky ground, may I think be expected, there would be about $35\frac{1}{2}$ millions cubic feet to be stored ; water which now all annually goes to waste.

12. It is possible that a reservoir here would be able to supply the town of Dholpur with water by gravity, if a water-supply is ever required for the capital, but this can only be ascertained by taking levels.

The accompanying key map illustrates the project.

APPENDIX III.

Note on the Proposed Storage Tonk at Seheri.

1. The site proposed for the Bund is about 2 miles down the nullah north of Seheri, and about $3\frac{1}{2}$ miles South South-west from Barri, near a Nim tree just above the junction of the nullah from Seheri, with the nullah from Nandraoli on the west.
2. The drainage area at this point is about 63 square miles; allowing an average rainfall of 26 inches and 30 per cent. to run off this rocky catchment, which I think may be expected, there would be about 1,143 $\frac{1}{2}$ millions cubic feet of water to be stored, all of which now annually goes to waste.
3. The Bund would be formed across the nullah, from a ridge of high ground near the Nim tree, to the high ground eastward in a north easterly direction, where the length is not great, and the nullah banks 20 ft. deep, so as to entirely close the present nullah.
4. On the east side from this point to Seheri there is a range of sandhills, which forms a natural Bund for about 2 miles.
5. On the west, a low earthen Bund will have to be made on the water shed which divides the Seheri nullah from the nullah on the west. This Bund will have to be taken up to the rocky ground at the foot of the hills, about 500 yards south-west of Amru-ka-pura.
6. This rocky ground will apparently form a natural and safe escape, and appears to be a suitable height for the high water level.
7. It can be raised if necessary; the level of high water level will have to be fixed after the capacity of the proposed reservoir at different levels, is compared with the probable quantity of water, which may be expected from the catchment area, all of which is rocky ground. I should think 30 per cent. might safely be taken.
8. The water stored would be taken away on the right bank, and will probably reach the surface for irrigation in the vicinity of Barri; in any case the large quantity of water stored at the high level and for some feet below it, will very likely admit of a high level Canal. This will have to be ascertained by levels. The whole country slopes away to the eastward, and would be commanded by the water stored here.
9. A masonry core wall would be necessary in the portion across the nullah; and should be carried by steps 10 feet or so below the surface well into the banks on both sides.
10. The site is an ideal one for a storage reservoir. There is a magnificent basin for the spread of the water which would probably

cover about four square miles. There is no good land in the proposed bed, at present it is intersected with nullahs, and of little use, so no compensation I think would be necessary. No village would I think be submerged, and there would be an extensive margin for cultivation as the water recedes.

About two miles of the proposed Bund already exists in the range of sandhills on the east, and for about 800 feet on the north. It is very seldom indeed that a site so favourable is met with for such a large project.

11. I strongly advise the plans and estimate being prepared as soon as possible.

APPENDIX IV.

The villagers at Amrukapura asked for help to prevent the small Tal above the village from leaking. The water is used for the fields below.

The State Engineer knows the circumstances, and his suggestion to put earth on the inner side of the face wall, appears to be all that is necessary.

The villagers were advised to submit an application through the local officials in the usual way.

APPENDIX V.

Note on the Proposed Construction of Storage Reservoirs adjoining Oomree

The State Engineer (Mr. Thorpe) took me to Nandraoli, Kaolo, and along the Oomree Bund, and showed the site of another Bund it is proposed to make.

As I understand it, the idea is to make a Bund between Nandraoli and Kaolo, with an escape at high water level over the rock eastward, towards Amrukapura, with the option of passing any surplus water, which might be required into the Oomree Bund on the north; and from this, passing any surplus into a proposed new Bund north-west forming a chain of three tanks, the overflow of No. 1 passing into No. 2, and from No. 2 into No. 3.

If this is correct I do not recommend it at present at all events, for the following reasons :—

- (1) The land between Kaolo and Nandraoli is cultivated now, if submerged with about 15 ft. of water (as I understand, is proposed to enable the surplus water to escape over the rock towards Anrukupura), this land would be lost for some time.
- (2) The present Oomree Bund cannot yet be trusted to be filled to the depth originally proposed and overflows as it is.
- (3) Untill this water is all used up, the need for more water here is not apparent, although it may be hereafter.

For these reasons it appears to be premature to think of spending money here in making another Bund.

What I would suggest for the present is—

- (1) To make the Oomree Bund perfectly safe; the section is strong enough, but the soil in some parts appears to be untrustworthy :—

The inner slope is a good deal cut up and longitudinal cracks are visible at the top. I would recommend a masonry or slabstone core wall being put in before next rains in all places where there is any doubt.

- (2) When all doubt has been removed to raise the high water level to the original height proposed or higher.
- (3) Irrigation ducts to be properly laid out and made as soon as possible, to prevent waste of water, and to bring the water to the fields of Zamindars, who I believe will then readily take it.
- (4) When it is found that there is not enough water in this tank to meet the demand, then a small Bund might be made, sufficient to flood the land between Nandraoli and Kaolo, and the surplus be directed to the Oomree Bund. This would benefit the fields between Nandraoli and Kaolo without swamping them entirely. It would cost less and the water or a portion of it would be stored in the Oomree Talao instead of the first one.

At the same time the nullah which it is proposed to Bund brings a good deal of water, and if it has not been already done, it would be worth while to see if a site for bunding up, or diverting to Oomree some of its water cannot be found higher up, so as to irrigate the land between Nandraoli and Kaolo instead of flooding it.

It would be a good thing I think also to make a raised roadway from the Bund across to the nearest high ground above high water level to

divide this large sheet of water into two parts. At present anyone wishing to cross has to go round one end or the other, a distance of a mile or more at least; also if any breach occurs in one part there is danger of all the water being lost.

The water when one part is filled might be allowed to pass over the natural ground at high water level into the other portion.

This is not an absolutely necessary work, but in a long bund of this sort is a good precaution, if funds are available, or as a Famine Relief Work.

APPENDIX VI.

Note on the Proposed Storage Reservoir on the River Parbati at Thomati-Mohari.

About six miles north of Barri, where the River Parbati passes between the villages of Mohari and Thomati, is a good site for a large storage reservoir.

The high ground on both sides approaches here. There is rock in the bed and on each side.

In the bed of the river are the remains of an old Badshahi Bund, a mass of solid masonry on rock about 350 feet long, 50 feet thick, and 10 feet high; the river in flood passes round each end of it, and in heavy floods is said to pass over it about 6 feet deep. No water was flowing at this date, 22nd November 1902.

The rock at the north end is of poor quality, shaley red sandstone, untrustworthy: at the south end rock is visible in the bed only. About 1,200 feet lower down, the river falls from this ledge of rock to a much lower level.

The section of the broken masonry does not lead one to suppose that the Mahomedans had the intention of making a high dam here, or of stopping all the water, probably a weir only to impound some water and to form a good crossing.

The site appears a good one for a large bund; it would be a grand but expensive work. It appears to be the last place on the course of the River Parbati, where rocky ground closes in the river on both sides. The gorge here at a height of about 50 or 60 feet would probably be about 2,500 feet across.

The site for a new bund would be at the north end of the rocks on which the village of Thomati is situated, across to a rocky mound opposite, known as the site of the Mohari Quarries. At both places the

sandstone rock is of good character, and is now quarried for building purposes. It is probable that this ridge stretches right across; this would have to be ascertained.

It would also probably be necessary to make an earthen shield bund, parallel to the river from the Mohari end, the north end, to the village of Barri, about a mile higher up, on the north bank, to prevent water passing off to the north.

There appears to be a site for an escape in a saddle in the range of rocky hills south-west of the village of Beranpur. This requires examination to see if the rock is sound here and could be trusted.

The basin is a grand one for the storage of water, and a lake could apparently be formed here four or five square miles in area. The whole country slopes away to the east to the borders of the State, a distance of about 25 miles. The soil is good, the surface unbroken by ravines, it is well populated, and irrigation would be certain.

A little silt might come, but I do not think it would in any way interfere with the usefulness of the work, as the catchment area is so good.

Until proper surveys have been carried out it is impossible to say what the cost of the project would be, or what land would be submerged, whether any compensation would be necessary, and how much land would be irrigated, and what returns might be fairly expected.

It may be beyond the resources of the State to attempt such a grand work for some time to come, but I strongly advise plans and estimates being prepared.

The catchment area of the river at this point is about 255 square miles. Allowing an average rainfall of 23 inches and 3 cents of this to run off, which is not improbable from such a rocky catchment, there would be about 4,430 millions cubic feet of water available for storage. At present this all goes to waste, not once but annually. If it can be stored and used for irrigation it would practically ensure the area commanded, about 60 square miles, from want of water.

At the same time it will be advisable to examine the course of the River Parbati from near its source, before any decision is formed, to see if any better sites exist higher up, and if so, whether it would be possible to make use of the water which could be stored.

APPENDIX VII.

Note on the Proposed Storage Tank at Mhar.

This is a site which has been suggested by Mr. Thorpe, the State Engineer, as a good site for a storage reservoir.

The drainage area at this point is about 89 square miles. Allowing 23 inches as the average annual rainfall, and 30 per cent. as the run off, there would be about 1,560 millions cubic feet available for storage, which now all goes to waste.

The site is an opening in a range of hills about 500 yards wide. On the north-east end the rock is visible. On the west side of the nullah there is a vertical bank about 40 feet high of hard soil covered with sand and coarse jungle; beyond this is another range of rock, a continuation apparently of the range at the north-east end of the proposed line.

The soil near the river is rich and good.

The river passes close under the high bank. At present there is a pool of still water about 5 feet deep extending above and below the site for about a mile, caused by a ledge of rock lower down, over which the bed falls to a lower depth.

It would be necessary to cut this through and to drain off the water, or there would be difficulty in getting in the foundations of the core wall at the proposed site.

Although the soil is good for an earthen bund I would suggest a masonry core wall, founded on rock if possible, in the main dam, or there may be leakage, or perhaps a breach, owing to the probable proximity of the rock below the surface.

The basin for the storage of the water is a good one. There is one village, Oomrekapura, in the bed; whether it would be submerged will depend upon the height of the high water level, which can only be determined after surveys have been made, and the capacity of the basin at different heights is compared with the probable amount of water expected.

There is also some cultivated ground, which will have to be taken into account.

The masonry core wall would have to be taken some distance into the sandhills to prevent any possibility of the water getting round. The sandhills may be safely used as a portion of the bund, which might be taken on to the rocky ridge on the south-west, where, if the levels admit, an escape might be found as well as at the north-east end.

The land which it is proposed to irrigate is situated on both sides of the nullah; how much of this can be commanded by this reservoir remains to be seen. Until plans and estimates are prepared it is impossible to say more. Owing to the rocky character of the ground beyond

Pura to the east, and the sparse population here, I fear the returns in this direction would be disappointing; only the land east of Mhar on both sides of the nullah for about $1\frac{1}{2}$ miles or so may perhaps be irrigable. Some wells also exist.

These are matters which will require careful consideration before the scheme is sanctioned.

The ducts should be surveyed, and the amount of land now cultivated and culturable should be ascertained. Until this is done it is difficult to say how much will be irrigated, or whether there will be a fair return upon the outlay, but the site is a good one, and I would suggest plans and estimate being prepared when Surveyors are available.

APPENDIX VIII.

Note on the Site of an old Bund at Tajpur.

Near this place is an old broken bund; there is a flat basin inside, about a mile square, which is being cut up by the flow of the water from the surface in the rains.

If the water which now cuts up this ground and goes to waste was impounded at the rocky gorge close to Tajpur, so as to inundate this basin, it would be a good thing.

I do not think it would be safe to trust the old bund, the work in it is not good; but a small masonry bund across the rocky bed about 150 feet or so lower down might be easily made.

It is doubtful if there would be any direct irrigation unless the levels will admit of the water reaching the ground north or north-east of Tajpur, but the cultivation of the bed, after the water was let out, ought to pay well.

I would recommend plans and estimate being prepared.

APPENDIX IX.

New Bund proposed near Hosainpur.

At Hosainpur, Mr. Thorpe, the State Engineer, showed me the site for a bund he proposes to make across a nullah, which passes west of the village. A small tank exists near the village, and the surplus water of the tank proposed might be made to pass into this if desired.

The site appears a good one, there is a good catchment, a good basin for storage, and good land below.

If the plans and estimate have not yet been prepared they might be done as soon as possible.

NOTE ON IRRIGATION
IN THE
DHOLPUR STATE
1905.

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NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION ON THE RIVER PARBATI IN THE DHOLPUR STATE.

On the 15th March 1905 the Consulting Engineer (Colonel Sir S. Jacob) went to Khanpur with the State Engineer (Mr. A. N. Thorpe). The next morning they visited Seheri, where a large storage tank, now called "Ram Sagar," after the present Maharaj Rana of Dholpur, is being carried out.

This is one of the large storage tanks suggested in November 1902. It is satisfactory to see the progress which has been made, and the excellent way in which the work is being carried out under Mr. Thorpe's supervision.

It is important that the escape should be on rock. To ensure this it is suggested that the bund be extended at the west end. The advantages obtained in the extra water which would be stored, and the less fear of any land being cut up by the overflow, are well worth the small extra cost.

2. From here they went *via* Oomree to Dhimri, about 7 miles west to north-west of Bari, and in the evening inspected the Parbati River and the site of a proposed storage reservoir on the river just above Barai.

The next day they rode up the river, inspecting sites on the river at Kuragaon and Khurdia, and encamped at Khannot. In the evening they went still higher up the river as far as Mandasil.

3. The following Note by Mr. Thorpe, on Irrigation from the River Parbati, dated 20th March 1905, will explain his ideas:—

Preliminary Report on the "Parbati River" Irrigation Project.

"1. The catchment of the Parbati River, where it leaves the hills near Thamoti-Mohari, is 340 square miles, which, assuming the rainfall at 24 inches, and the "run-off" at 30 per cent., would give some 5,700 million cubic feet of water as available for storage.

"2. The survey of a dam at this site was carried out during the season 1903-04, which proved that a dam with the weir crest 70 feet above the river bed would give a storage capacity of 5,000 m. c. ft., but an examination of the river bed for foundations showed that it was composed of a most unreliable shale, which could be traced to a depth of 18 feet without any change in its character. Another objection against a dam at this point was that this highly cultivated village of Barai would be permanently submerged and an ancient temple destroyed.

"3. These considerations led to the abandonment of the site and a systematic examination of the upper reaches of the river with a view to obtaining sounder sites; and if no sufficiently large basin could be found, the selection of several smaller ones to impound the whole of the available water. One consideration had, however, to be kept in view, namely—that the best land for irrigation lay on the large plain to the north of the river, and to the east of Baseri, and that, wherever the storage might be situated the canal alignment should eventually command this plain.

"4. The examination of the upper reaches of the river showed that the river bed consisted of a number of "giant steps," level reaches, of ten miles long, being succeeded by sharp short falls.

"5. The Parbati River, rising in the Karauli State, enters Dholpur through a deep gorge near Bilouie, from whence to Chandpur the river continues to rush down its rocky bed at great velocity, owing to the steep grade of its bed. At Chandpur the first of the "steps" occur, followed by a short reach and a further drop of 8 feet. At Baragaon another drop of 10 feet occurs, followed by a level stretch of 3 miles, until the Mandasil Falls are reached. At this point a sheer drop of 15 feet is followed by a further fall of 25 feet in half a mile. Another level stretch of one and a half miles ends at Khurdia, where a rapid of half a mile lowers the river bed another 23 feet. The succeeding reach of 6 miles brings us to Liloti, where a drop of 15 feet in 300 yards is followed by a one mile reach, ending with the great rock barrier at Kuragaon, where with a leap of 35 feet in a mile, the river enters a maze of ravines some eight miles long, ending at Banora, with a gently-falling bed from there to Barai, where a drop of 3 feet in 100 yards occurs. From Barai to Thamoti the level is maintained, but below the last-named the river bounds out from the hills at immense velocity, down a steep rock with a slope of 40 feet to the mile, the total drop being some 60 feet.

"6. During its course through the hills the river is joined by two large tributaries, one on each bank. From the south the Kharrair Nadi leaves the very rugged hills near Domai, and proceeds on a fairly level bed through highly-cultivated country to Sirmuttra, where a fall of 30 feet in one mile brings it to the river bed level a short distance above Khurdia.

"7. From the north the Sairni River enters from Karauli through the natural basin of Mahar, and continues on the level to Barcunjara, whence a fall of 40 feet in three miles discharges it into the Parbati near, but slightly below, Kuragaon.

"8. From an irrigation point of view the most favourable sites for storage tanks must necessarily be immediately above one of the falls, which, composed as they are of rock barriers, secure that most necessary consideration, a good foundation for a dam. In addition to this these points must obviously give the longest stretch of level bed, and therefore the greatest storage capacity, and lastly, being immediately above a fall, the greatest command of the irrigable area below.

"9. The above considerations therefore confine the choice of sites to five, viz:—

	Catchment Area Square Miles	Runoff in Inches	Water available for Storage, Milion Cubic Feet.
(a) Mandasil	196.24	24½	1,773
(b) Khurdia	140.74	24	2,358
(c) Kuragaon	196.10*	24	3,271
(d) Barai	240.60*	24	4,030
NORTH BRANCH			
(e) Mahar	89.66	23	1,560

* Excluding the C.A. of Mahar.

"Site (a) Mandasil was rejected on account of the highly-cultivated state of the country, and the small basin which a casual inspection showed could not hold the available "run-off" without an unduly high dam.

"Site (b) Khurdia has been surveyed and found a fairly favourable site where a dam 61 feet high to weir crest would store the required quantity of water. The objections to this site are, the very sandy bed, the broken ground on the south bank through which the irrigation canal must necessarily lead, and the cross drainage which the canal must encounter. The broken ground extends some 1,000 yards, after which a large level plain is encountered. A small amount of cultivation in Khurdia village will be permanently submerged, but as the total rental of that village is only Rs. 2,000 per annum this is a minor consideration. Some good land in Mandasil village will be temporarily submerged.

"Site (c) Kuragaon was rejected on account of the sand-hills unduly confining the basin, and the absence of irrigable land below.

"Site (d) Barai, although not an ideal site, is a good one, with fairly good foundations across the river bed. It is extremely favourable for the canal line, which would take off from the north bank and command the whole of the Baseri Plain. With a weir crest of 47 feet above river bed level it would have a capacity of 2,374 m.c.ft. With a dam 71 feet high at weir crest the capacity would be 11,220 m.c.ft, which for a sand dam would appear somewhat hazardous.

"Site (e) Mahar has been surveyed, and with a weir crest 43 feet above river level would contain 2,269 m.c.ft. The basin is an ideal one, but some valuable land would be submerged, and the irrigable area below is somewhat limited.

"10. Taking all considerations into account it would appear that the best Project for utilising the vast quantity of water now flowing away unused to the sea would be that in which three large storage tanks are involved; the two high level ones irrigating all available land within a reasonable distance and discharging their surplus water down the river bed into the lower tank, which should command the vast Baseri Plain.

"11. Pending the completion of the detailed estimates and the comparison of cost, the following would appear to be the most favourable sites for a Project of this class, viz :—

	Catchment Area Square Miles	Storage Capacity. Million Cubic Feet.
(1) Khurdia	140.74	2,358
(2) Mahar	89.66	2,269
(3) Baria 330.26	99.86	2,374
Combined... ..	330.26	7,001

In this Project Nos. 1 and 2 would discharge their surplus waters into No 3, and the whole Project would have an irrigation capacity of 70,000 acres."

4. The upper parts of the River Parbati, as Mr. Thorpe states, consist of level reaches, succeeded by rocky falls; the most favourable sites for dealing with the river are naturally just above each of these falls, because at such places :—

- (1) There is a greater command of the country below.
- (2) There is no difficulty about foundations.
- (3) There is plenty of material at hand from the rock close by.
- (4) There is the best storage capacity from the long level stretch of river bed, above the fall.

5. There are five such sites on the River Parbati at—

- (1) Mandasil.
- (2) Khurdia.
- (3) Kuragaon.
- (4) Barai.
- (5) Thamoti.

And one on the north branch at Mahar.

Regarding—

(1) *Mandasil*.—I agree with Mr. Thorpe for rejecting this, for the reasons he states.

Regarding—

(2) *Khurdia*.—The objections to this site are the sandy nature of the proposed reservoir bed; the broken ground and cross drainage on the south bank through which the canal would have to pass; the rocky range which somewhat confines the basin and the scope of any canal on the left bank for some distance.

At the same time the site has advantages. There is good rock for the foundations in the bed of the river; there is a good site for the escape on the left bank on rock at the north end; there is any amount of good material—rock, sand and kunkar near for making the dam; a great

portion of the bund on the right bank could be made of sand ; there would be little land of any value submerged ; a great part of the catchment area is rock, and any reservoir would quickly fill every year ; the high level at which the water would be stored ought to enable it to command a large area.

The sand in the bed of the proposed reservoir may cause some silting up, but would not, I think, give much trouble, for it would take many years to silt up the river bed to its banks, and the bed could be cultivated as the water receded.

If any storage reservoir is made here, it will be advisable to provide large sluices for scouring in case of need, and also to allow water to flow freely down the river to fill any other reservoirs which may be made hereafter. This is important.

The canal line was not marked out, but I understand the country has been levelled and the general line has been fixed.

Regarding—

(3) *Kuruguan*.—Mr. Thorpe states : “ This was rejected on account of the sand-hills unduly confining the basin, and the absence of irrigable land below.”

There is such a good crossing of the river here on solid rock, “ a great rock barrier with a leap of 35 feet in a mile,” and such a profusion of rock lying about, that it seems to be an ideal place for a masonry dam or weir, as far as the site is concerned.

No work or expense would be required on the left bank ; there is a natural bund of rock on this side, and it seemed that an earthen bund might be made on the right bank, across to Bhaonpura, or the high ground in this direction, and if this is feasible, there would apparently be a good storage basin.

At the same time it is quite possible the levels will not admit of this ; or too much cultivated land may be submerged ; or, as Mr. Thorpe thinks, it might be impossible to reach irrigable land below. It is true there is any amount of good land eastward on the Baseri plain ; to reach this, however, it would be necessary to cross the Sairni nullah ; to reach good land on the right bank would also present great difficulties ; any canal on either bank would have to cross a great deal of broken ground, and may prove too costly, even if possible.

The site, however, appears such a good one that it is suggested levels be taken, and if found to be at all feasible, proper plans and estimates be prepared.

Regarding—

(4) *Barai*.—The basin is large, there is rock visible in the river bed, and Mr. Thorpe states rock is found right across, and that an escape on rock can be made somewhere at the east end.

There would be less difficulty, it is true, in taking a canal off from here than at other sites ; and a canal would command a great part of the Baseri plain.

It is not, however, an ideal site, and the plans and estimates do not appear to be fully prepared. Without knowing more and comparing the plans and estimates with alternative Projects I do not feel justified in giving a decided opinion on this scheme.

Regarding—

(5) *Thamoti*.—It will be remembered, perhaps, that a Project was proposed by the State Engineer (Mr. Thorpe) in November 1902 for making a large storage reservoir on this River Parbati, at a place called Thamoti—Mohari (Site No. 5), about 2 miles lower down than Site No. 4. No plans and estimate had been prepared, but the Consulting Engineer, while then approving of this site, suggested that before any decision was formed, it would be advisable to examine the course of the river from its source to see if any better sites exist higher up; and if so, if it would be possible to make use of the water which could be stored.

Mr. Thorpe now reports that an examination of the river bed here for foundations showed that it was composed of a most unreliable shale, which could be traced to a depth of 18 feet without any change in character, and that the highly-cultivated village of Barai would be permanently submerged, and an old temple destroyed, and for these reasons this site was abandoned.

Regarding—

(6) *Mahar*.—Mr. Thorpe states that the project has been surveyed, and that a weir with a crest 43 feet above river level would contain 2,269 million cubic feet, but some valuable land would be submerged, and that the irrigable area below is somewhat limited; the quantity in either case is not stated. The remarks made by the Consulting Engineer, therefore, in December 1902 on this Project still hold good. It is unnecessary to repeat them here.

6. The above remarks show how the matter now stands. The River Parbati is the main artery, as it were, of the Dholpur State, and in the interests of the State the water of this river should *all* be stored, if it is possible to store it. It rises in the highest part of the State; it has a fine catchment of a range of hills of sand-stone rock, which ensure a good flow-off; it has ledges of rock in places where any amount of good material is available for making dams; above its natural falls it has a good command of the country; there is any amount of good land below (the whole State of Dholpur in fact) to be irrigated, almost every drop of water could be utilised, and all now goes to waste.

It would be difficult to find conditions more favourable for Irrigation.

The real difficulty is how to make the best use of these great natural advantages.

7. The two ways of dealing with the river appear to be :—

- (1) To make storage reservoirs on the river, or its tributaries; or,
- (2) By permanent weirs on the river, above some of the falls, to divert the water to where it can be stored elsewhere, and used as required.

Although no places for doing (2) have been pointed out, yet it is well to bear the possibility in mind. During the months that irrigation is not required and water is flowing in the river the canals might be used, perhaps, to convey any surplus water to storage tanks elsewhere, if suitable places exist.

Large storage tanks have many advantages over small tanks; storage reservoirs, therefore, should be as large as circumstances permit. The higher up these storage tanks can be made, as a general rule, the greater command they will have, and being on the same river the higher ones can be made to supplement those below.

8. Not a drop of water should be allowed to go to waste. This is the great principle which should be kept steadily in view. There is no need to be in a hurry. There are other good Projects which can be taken up. In the meantime too much trouble cannot be taken to thrash out alternative Projects and compare results.

9. The catchment of the River Parbati near Thamoti is about 340 square miles, and assuming the run-off as 30 per cent. of an average annual rainfall of 24 inches, about 6,000 million cubic feet of water is available for storage, sufficient to irrigate about 60,000 acres, and every year this is passing away unused.

10. It is better not to attempt the storage of this in one place, but to distribute it over three or four places, and although it is easy to fix upon the most likely places (as Mr. Thorpe has done) it is difficult to say which is the best to take up first, until each Project has been properly prepared and it is possible to compare one with the other. Other things being equal the higher up the better, and as good land gives a better return than land of an inferior quality, the Project which would command the best land should be preferred.

11. In the meantime further investigation is advisable; the plans and estimates of alternative Projects should be carefully prepared; the land which can be irrigated from each should be marked out; the anticipated returns from each Project should be carefully estimated, the results compared and the opinion of the Revenue Officials invited.

12. It is clear the River Parbati might be made a source of great benefit to the State; at present it is entirely unused; and the best way of storing all this water I consider to be the greatest and most important work that the State can undertake.

S. S. JACOB, Col.,
Consulting Engineer for Irrigation.